DESCRIPTION

PUMP SYSTEM

Technical Field

The present invention relates to a pump system, and more particularly to a large-sized pump system for delivering water from a river, a reservoir, or the like to another place.

Background Art

When a water level of a river increases due to heavy rain such as storm, the river may be flooded in some cases. In order to prevent such flood of the river, a large-sized pump system (pump plant) has been used to deliver water from the river to another place. A pump incorporated in such a pump system is an axial-flow-type or mixed-flow-type pump having a low pump head and being capable of delivering a large amount of water. This type of pump comprises an impeller disposed in a pump casing. The impeller is rotated by a drive source disposed outside the pump casing through a rotational shaft. Generally, a delivery valve is provided at an outlet side of the pump so as to prevent a fluid from flowing back into the pump when the operation of the pump is stopped.

When constructing the aforementioned pump system, the pump is fixed to a mount surface of an installation site by anchor bolts. An inlet-side flange (an inlet mouth) and an outlet-side flange (an outlet mouth) of the pump are connected respectively to an inlet passage and an outlet passage, which have been installed in advance in the installation site, by

using bolts and nuts. At this time, centering operation is carried out so as to align the inlet-side flange with the inlet passage, and the outlet-side flange with the outlet passage. The pump and the drive source are assembled in the installation site. When assembling these components, alignment operation is carried out so as to align the rotational shaft and a drive shaft of the drive source with each other.

In this manner, the construction of the pump system requires many operations such as the installing of the pump, the centering, and the assembling of the pump and the drive source, which are very laborious and time-consuming. Especially, a high technical ability and experiences are required for a working person to perform the positioning of the components such as the pump and the drive source and the alignment of the rotational shaft and the drive shaft. Further, when performing the maintenance of the pump system, the components should be dismantled and then assembled, resulting in large labor and cost. Furthermore, since the delivery valve is required to be provided at the outlet side of the pump, a constructing cost of the pump system becomes large and the delivery valve should be maintained regularly.

Disclosure of Invention

The present invention has been made in view of the above drawbacks. It is therefore an object of the present invention to provide a pump system which can greatly reduce the labor, the cost, and the time for the installation and the maintenance.

In order to achieve the above object, according to one

aspect of the present invention, there is provided a pump system comprising: a pump having an impeller and a drive source which are disposed in a pump casing; at least one pair of support pedestals which are symmetrically disposed on an installation surface for said pump; and a connecting mechanism for connecting the pump to at least one of an inlet passage and an outlet passage, the connecting mechanism being stretchable and contractible.

In a preferred aspect of the present invention, the connecting mechanism comprises: a pair of flange members disposed so as to face each other; a stretchable and contractible member for connecting the flange members to each other in a liquid-tight manner; and a relative moving mechanism for moving the flange members relative to each other so as to change a distance between the flange members.

According to the present invention, by simply placing the pump onto the pump placement surfaces of the support pedestals, the pump is positioned automatically and accurately. Therefore, the aforementioned centering operation and the installation operation using the anchor bolts can be eliminated. Further, by using the stretchable and contractible connecting mechanism, the pump can be easily connected to the inlet passage and/or the outlet passage without using bolts and nuts. Furthermore, since both the impeller and the drive source are disposed in the pump casing in advance, it is not required to perform the alignment of the rotational shaft of the impeller and the drive shaft of the drive source in the installation site.

In a preferred aspect of the present invention, the drive source is a brushless synchronous motor.

According to the present invention, the pump can be lightweight, and hence the installation of the pump can be easily carried out.

In a preferred aspect of the present invention, a liquid passage including the outlet passage has a siphon shape.

According to the present invention, it is possible to prevent the fluid from flowing back into the pump without using the delivery valve. Therefore, the manufacturing and constructing cost of the pump system as a whole can be reduced and the maintenance operation of the delivery valve can be eliminated.

According to the present invention, the number of processes required in installing the pump system can be reduced compared to a conventional pump system. Therefore, it is possible to greatly reduce the labor, the cost, and the time spent for the installation of the pump system.

Brief Description of Drawings

FIG. 1A is a cross-sectional view showing a pump system according to a first embodiment of the present invention;

FIG. 1B is a plan view of the pump system shown in FIG. 1A;

FIG. 2 is a plan view showing a plurality of the pump systems shown in FIG. 1B;

FIG. 3A is an enlarged cross-sectional view of a pump shown in FIG. 1A;

FIG. 3B is a cross-sectional view taken along line III-III illustrated in FIG. 3A;

FIG. 4A is a front view showing a connecting mechanism incorporated in the pump system according to the embodiment of the present invention;

FIG. 4B is a view showing the connecting mechanism as viewed from a direction indicated by an arrow IVb illustrated in FIG. 4A;

FIG. 4C is a cross-sectional view taken along line IVc-IVc illustrated in FIG. 4B;

FIG. 5A is an enlarged view showing a part Va illustrated in FIG. 4A; and

FIG. 5B is a cross-sectional view taken along line Vb-Vb illustrated in FIG. 5A.

Best Mode for Carrying Out the Invention

A pump system according to an embodiment of the present invention will be described below with reference to the drawings.

FIG. 1A is a cross-sectional view showing a pump system according to a first embodiment of the present invention, and FIG. 1B is a plan view of the pump system shown in FIG. 1A. FIG. 2 is a plan view showing a plurality of the pump systems shown in FIG. 1B. The arrows A illustrated in FIG. 1A indicate a flowing direction of a liquid.

As shown in FIGS. 1A and 1B, a pump system 1 comprises a base 2 having an inlet passage 3 and an outlet passage 4 provided therein, and a pump 5 disposed between the inlet passage 3 and the outlet passage 4. An installation surface 2a, which is inclined with respect to a horizontal plane, is formed in the base 2, and two pairs of support pedestals (support members)

6 are fixedly provided on the installation surface 2a. The pump 5 is placed on these support pedestals 6. An inlet mouth 5a of the pump 5 is connected to a downstream-side open mouth 3b of the inlet passage 3, and an outlet mouth 5b of the pump 5 is connected to an upstream-side open mouth 4a of the outlet passage 4 through a connecting mechanism 10.

A liquid passage including the outlet passage 4 has a siphon shape (i.e., an inverted U-shape). In this embodiment, the pump 5 and the outlet passage 4 form a siphon passage. A siphon-breaking valve 7 is provided at a highest position of the outlet passage 4. When the operation of the pump 5 is stopped, the siphon-breaking valve 7 is activated in order to prevent a liquid from flowing back into the pump 5.

A stop log (i.e., a gate) 11 is provided so as to cover an upstream-side open mouth 3a of the inlet passage 3, and a horizontal bar screen (i.e., a separator) 12 is provided upstream of the stop log 11. The horizontal bar screen 12 has a plurality of bars (not shown) disposed in parallel, and is provided for allowing only small rocks and rubbishes to pass therethrough. As shown in FIG. 2, in an installation site of the pump system, a plurality of the pump systems 1 are installed in parallel.

FIG. 3A is an enlarged cross-sectional view of a pump shown in FIG. 1A, and FIG. 3B is a cross-sectional view taken along line III-III illustrated in FIG. 3A. As shown in FIGS. 3A and 3B, the pump 5 comprises a cylindrical pump casing 15, an axial-flow-type or mixed-flow-type impeller 16 housed in the pump casing 15, and a drive source 17 for rotating the impeller 16. The impeller 16 is coupled to the drive source 17 through

a rotational shaft 18, and the drive source 17 is fixed to an inner surface of the pump casing 15 through guide vanes 19. The pump 5 is installed in such a state that the position of the outlet mouth 5b is higher than that of the inlet mouth 5a and the rotational shaft 18 is inclined at a predetermined angle with respect to a horizontal plane. The pump 5 is a so-called axial-flow-type or mixed-flow-type tubular pump in which the impeller 16 and the drive source 17 are disposed in the pump casing 15. This type of pump has features such that a pump head is relatively low and a flow rate of a liquid (i.e., a discharge rate) is high.

In this embodiment, a brushless synchronous motor is used as the drive source 17. The use of the brushless synchronous motor allows the drive source 17 to be lightweight and small in size.

As shown in FIG. 3B, the support pedestals 6 as a pair have the same shape as each other, and are symmetrically disposed about a center line of the pump 5, i.e., the rotational shaft 18. Each of the support pedestals 6 has a slope surface (a pump placement surface) 6a formed on an upper end portion thereof. The slope surfaces 6a are symmetrically inclined with respect to the installation surface 2a, so that when the pump 5 is placed onto the slope surfaces 6a, an outer circumferential surface of the pump casing 15 is held in contact with the slope surfaces 6a.

The pump 5 is not fixed to the support pedestals 6 when being installed on the installation surface 2a, but is simply placed on the slope surfaces 6a of the support pedestals 6.

Once the pump 5 is placed on the slope surfaces 6a, the center line of the pump 5 and the center line between the support pedestals 6 coincide with each other, and the pump 5 is thus positioned automatically. Further, the pump 5 on the slope surfaces 6a is moved downwardly along the installation surface 2a by gravity until the inlet mouth 5a of the pump 5 is brought into contact with the downstream-side open mouth 3b of the inlet passage 3. A relative position between the downstream-side open mouth 3b and the support pedestals 6 is adjusted in advance based on the size of the pump 5, so that centering between the inlet mouth 5a and the downstream-side open mouth 3b of the inlet passage 3 is performed automatically only by placing the pump 5 onto the slope surfaces 6a of the support pedestals 6.

The inlet mouth 5a is pressed against the downstream-side open mouth 3b by gravity, whereby the inlet mouth 5a is connected to the downstream-side open mouth 3b. An annular seal member (not shown) such as an O-ring is provided on a contact surface of the downstream-side open mouth 3b to be brought into contact with the inlet mouth 5a so that the downstream-side open mouth 3b and the inlet mouth 5a are connected in a liquid-tight manner. Although two pairs of the support pedestals 6 are provided in this embodiment, only one pair of support pedestals extending in a longitudinal direction of the pump 5 may be provided, or more than two pairs of support pedestals may be provided. Further, although the slope surfaces 6a of the support pedestals 6 have a flat shape in this embodiment, each of the slope surfaces 6a may be a curved surface whose shape corresponds to the outer circumferential surface of the pump casing 15.

The outlet mouth 5b of the pump 5 is connected to the upstream-side open mouth 4a of the outlet passage 4 through the connecting mechanism 10. This connecting mechanism 10 is stretchable and contractible in a flowing direction of a liquid passing therethrough. Hereinafter, the connecting mechanism 10 will be described with reference to FIGS. 4A through 4C. FIG. 4A is a front view showing a connecting mechanism incorporated in the pump system according to the embodiment of the present invention, FIG. 4B is a view showing the connecting mechanism as viewed from a direction indicated by an arrow IVb illustrated in FIG. 4A, and FIG. 4C is a cross-sectional view taken along line IVc-IVc illustrated in FIG. 4B.

As shown in FIGS. 4A through 4C, the connecting mechanism 10 comprises a pair of flange members 20 disposed so as to face each other, a stretchable and contractible member 21 for connecting the flange members 20 to each other in a liquid-tight manner, a relative moving mechanism 22 for moving the flange members 20 relative to each other so as to change a distance between the flange members 20, and a plurality of (four, in this embodiment) slide guides 23 for guiding a movement of the flange members 20. The relative moving mechanism 22 comprises a plurality of (two, in this embodiment) drive motors (geared motors) 24, a plurality of (four, in this embodiment) gear mechanisms 25 for converting rotational motion into linear motion, and a plurality of (two, in this embodiment) drive shafts 26 for coupling the drive motors 24 to the gear mechanisms 25.

The flange members 20 and the stretchable and contractible member 21 have a substantially elliptical shape. The

stretchable and contractible member 21 may preferably comprise a rubber having a high flexibility and a high waterproofing property. This stretchable and contractible member 21 is fixed to inner surfaces of the flange members 20 which face each other, and has a U-shaped cross section so as to easily stretch and contract. The flange members 20 are thus connected through the stretchable and contractible member 21.

The gear mechanism 25 and the slide guide 23 are disposed adjacent to each other and are arranged along a circumferential direction of the flange members 20 at substantially equal intervals. The two drive motors 24 are disposed in the vicinity of side surfaces of the flange members 20 and positioned symmetrically about a center of the flange members 20. Each of the drive motors 24 is coupled to the two gear mechanisms 25 through the drive shaft 26 so that power of the drive motor 24 is transmitted to the gear mechanisms 25 through the drive shaft 26.

FIG. 5A is an enlarged view showing a part Va illustrated in FIG. 4A, and FIG. 5B is a cross-sectional view taken along line Vb-Vb illustrated in FIG. 5A.

As shown in FIGS. 5A and 5B, the gear mechanism 25 comprises a screw shaft 30 extending perpendicularly to the flange members 20, a worm wheel 31 fixed to the screw shaft 30, a worm 32 meshing with the worm wheel 31, and a female screw member 33 in which the screw shaft 30 is threaded. The worm wheel 31 and the worm 32 are housed in a first gear casing 34, and the female screw member 33 is housed in a second gear casing 35. The first gear casing 34 is fixed to one of the two flange members 20, and

the second gear casing 35 is fixed to the other.

As shown in FIG. 5A, bearings 37 for rotatably supporting the screw shaft 30 are provided in the first gear casing 34, and the worm wheel 31 is disposed between these bearings 37. As shown in FIG. 5B, the worm 32 is fixed to a support shaft 38 that is rotatably supported by bearings 39 disposed in the first gear casing 34. The support shaft 38 is coupled to the drive shaft 26 through a shaft coupling 40. The drive shaft 26 may be extended so that the worm 32 is fixed to the extended portion of the drive shaft 26.

A male screw 30a is formed on a circumferential surface of the screw shaft 30, and a female screw 33a is formed on an inner circumferential surface of the female screw member 33. A plurality of balls (not shown) are provided between the male screw 30a and the female screw 33a, so that when the screw shaft 30 is rotated, the balls circulate while being brought into rolling contact with the male screw 30a and the female screw 33a. A set of the screw shaft 30 and the female screw member 33 having the above structure is called a ball screw which can reduce a friction loss and can improve a power-transmission efficiency.

The slide guide 23 is disposed near the gear mechanism 25. This slide guide 23 comprises a column-shaped slide member 41 extending perpendicularly to the flange members 20, a cylindrical guide bush 42 for guiding a movement of the slide member 41, and a housing 43 for housing the guide bush 42. The slide member 41 is fixed to one of the two flange members 20, and the housing 43 is fixed to the other. The slide member

41 is smoothly fitted into the guide bush 42, and is movable relative to the guide bush 42. A moving direction of the slide member 41 relative to the guide bush 42 corresponds to a moving direction of the screw shaft 30 relative to the female screw member 33.

With this structure, when the drive motor 24 (see FIG. 4B) is energized, the power of the drive motor 24 is transmitted to the worm wheel 31 through the drive shaft 26 and the worm 32, thus rotating the worm wheel 31 and the screw shaft 30 integrally. As the screw shaft 30 rotates, this screw shaft 30 moves relative to the female screw member 33, whereby the distance between the flange members 20 is changed. The two drive motors 24 illustrated in FIG. 4B are controlled so as to rotate synchronously at the same rotational speed, whereby the flange members 20 are moved while keeping parallel to each other.

The connecting mechanism 10 having the above structure is disposed between the outlet mouth 5b of the pump 5 and the upstream-side open mouth 4a of the outlet passage 4 (see FIG. 3A). When installing the connecting mechanism 10, the drive motors 24 moves the flange members 20 to increase the distance between the flange members 20, so that the one of the flange members 20 is brought into contact with the outlet mouth 5b of the pump 5 and the other is brought into contact with the upstream-side open mouth 4a of the outlet passage 4. The flange members 20 are pressed against the outlet mouth 5b of the pump 5 and the upstream-side open mouth 4a of the outlet passage 4, respectively, by the drive motors 24 and the gear mechanisms

25, whereby the outlet mouth 5b and the upstream-side open mouth 4a are connected through the connecting mechanism 10 in a liquid-tight manner. It is desirable to provide an annular seal member on at least one of the contact surfaces of the flange members 20 to be brought into contact with the outlet mouth 5b and the upstream-side open mouth 4a. An O-ring is preferably used as the seal member.

The flange members 20 and the stretchable and contractible member 21 may have a circular shape or a rectangular shape instead of a substantially elliptical shape as in this embodiment. Specifically, the shape of the flange members 20 and the stretchable and contractible member 21 is determined according to the shape of the outlet mouth 5b of the pump 5 and the upstream-side open mouth 4a of the outlet passage 4. Although the aforementioned connecting mechanism 10 comprises the gear mechanisms 25 and the drive motors 24 as the relative moving mechanism 22, one or more power cylinder mechanisms utilizing a pressure of a fluid such as a gas may be used as the relative moving mechanism.

Although the pump 5 of this embodiment is a so-called inclined pump in which the pump 5 is obliquely installed, the present invention is also applicable to a so-called horizontal pump in which the pump is horizontally installed. In the case of the horizontal pump, it is desirable to provide the aforementioned connecting mechanisms at both the outlet side and the inlet side of the pump. With such an arrangement, the inlet mouth and the outlet mouth of the pump can be connected respectively to the downstream-side open mouth of the inlet

passage and the upstream-side open mouth of the outlet passage in a liquid tight manner. In this case also, the centering between the inlet mouth of the pump and the downstream-side open mouth of the inlet passage and between the outlet mouth of the pump and the upstream-side open mouth of the outlet passage can be performed automatically by simply placing the pump onto the slope surfaces (i.e., the pump placement surfaces).

Industrial Applicability

The present invention is applicable to a pump system for delivering water from a river, a reservoir, or the like to another place.